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**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**
**Preparing Activity: KSC**

**NASA/KSC-27 15 00.49 98 (October 2007)**
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**Superseding**
**NASA/KSC-27 15 00.49 98 (February 2007)**

**NASA/KSC GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated January 2009**

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DIVISION 27 - COMMUNICATIONS

SECTION 27 15 00.49 98

INTERMEDIATE/RADIO FREQUENCY COMMUNICATIONS

**10/07**

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SECTION 27 15 00.49 98

INTERMEDIATE/RADIO FREQUENCY COMMUNICATIONS
**10/07**

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**NOTE: This specification covers the requirements for the requirements for broadband communication distribution systems (BCDS). Accordingly, tailor this section carefully to suit project conditions and to meet project requirements.**

**Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

**Remove information and requirements not required in respective project, whether or not brackets are present.**

**Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.**
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PART 1 GENERAL

1.1 REFERENCES

**********
**NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.**

**Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.**

**References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.**

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B 221 | (2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM D 1248 | (2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE Std 802.7 | (1989) Recommended Practices for Broadband Local Area Networks |

JOHN F. KENNEDY SPACE CENTER (KSC)

| | |
|---|---|
| KSC-STD-E-0012 | (Rev A; 1974; Am 1; 1978) Bonding and Grounding |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2007; AMD 1 2008) National Electrical Code - 2008 Edition |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA/EIA-606-A | (2002) Administration Standard for the Telecommunications Infrastructure |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 76.605 | Technical Standards |

## 1.2 SYSTEM DESCRIPTION

Community antenna television (CATV) system, commonly referred to as cable television, is a network of cables, headend, electronic and passive components that process and amplify television (TV) signals for distribution from the headend equipment to the individual television outlets.

BCDS, based on CATV design principles, provides a frequency-division multiplexed RF communications network for video, audio, and IEEE Std 802.7 broadband Local Area Networks. The existing inbound path occupies the frequency spectrum from 5-112 MHz. The existing outbound path occupies the frequency spectrum from 150-450 MHz. Install BCDS in accordance with 47 CFR 76.605.

### 1.2.1 Mid-Split Architecture

The mid-split design is no longer used in the CATV arena and is not supported by CATV amplifier manufacturers. Because the amplifiers are no longer available, new facility design requires the inbound path to occupy the frequency spectrum from 5-65 MHz and the outbound path to occupy the frequency spectrum from 80 to 862 MHz (65/80 split).

Future system growth requires the inbound path to be used for set-top box data return.

The headend to facility path wiring is not provided under this contract. The transmission path typically uses two single-mode fibers, or CATV cable.

### 1.2.2 Scope

The scope of work encompasses inside-plant horizontal/vertical riser, trunk/distribution cable, taps, splitters, directional couplers, connectors, customer faceplate, drop cable, inbound path fiber-optic transmitter, outbound path fiber-optic receiver, active electronics required for internal building distribution and interfacing to outside BCDS cable plant, and backbone cables and connecting hardware to transport BCDS signals between equipment items in a building. Transmission equipment must provide BCDS channels using 1550 nm fiber optic transmitter/receivers for the outbound path and 1310 nm transmitter/receivers for the inbound path.

Work under this contract must include the following:

a. The BCDS electronics systems and equipment, cable, terminations, etc., comprising a complete broadband distribution system. Provide system design and any supplementary systems equipment/components required to meet the performance requirements of the system, as part of the bid.

b. All work within the communications equipment room and telecommunications room, horizontal and backbone distribution, including but not limited to:

1. Installation of appropriately rated trunk and distribution cable and coaxial drop wiring as indicated or otherwise required.

2. Installation of equipment cabinets, backboards, amplifiers, taps and associated bonding and grounding.

3. Installation of cable support trays, risers and wall penetration.

4. Termination of all cables.

5. Provide all cables for interconnections of all components, as required for a complete and operating system.

6. Testing of the completed BCDS installation.

7. Installation spares

## 1.3 ENVIRONMENTAL REQUIREMENTS

Connecting hardware must be rated for operation under ambient conditions of

0 to 60 degrees C and in the range of 0 to 95 percent relative humidity, non condensing.

1.4 QUALIFICATIONS

1.4.1 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract must be commercially available off-the-shelf and must be from manufacturer's that have a minimum of three (3) years experience in producing the types of systems and equipment specified. Materials and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products and must be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation.

1.4.2 Contractor Qualifications

Installation of the system addressed in this section must be by a Contractor with a minimum of three (3) year's experience in installing CATV video systems of similar nature and magnitude.

1.5 SUBMITTALS

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**NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Keep submittals to the minimum required for adequate quality control.**

**A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.**

**For submittals requiring Government approval on Army projects, use a code of up to three characters within the submittal tags following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

**Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.**

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control

approval.][for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Preliminary Drawings

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Return Path Transmitter

Forward Path Receiver

Amplifier

Taps

Connectors

Cable

Splitters

Power Supply

Couplers

Equalizers

Equipment Cabinet

SD-05 Design Data

Design Analysis and Calculations

Bill of Material

SD-07 Certificates

Qualifications

SD-09 Manufacturer's Field Reports

Test Plan

Field Test Report

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

As-Built Drawings

Cable Schedule

1.5.1 PRELIMINARY DRAWINGS

Prior to the start of work, submit preliminary drawings of the following:

Scaled 1:50 1/4 inch per foot main equipment room floor plans showing the planned location of all installed BCDS components.

Scaled 1:100 1/8 inch per foot floor plans showing the planned location of all BCDS outlets. Provide the estimated length with an approved variance. This length is from the tap to the user outlet.

Drawings must be CAD generated on size "F" sheets. Submit reproducible hard copies. Obtain electronic files of the building floor plan from the Contracting Officer.

1.5.2 PRODUCT DATA

Provide specification sheets and/or manufacturers catalog data for all equipment.

1.5.3 DESIGN DATA

Submit Design analysis and calculations consisting of the power supply capacity, distribution calculations, and outlet port calculations with schematic diagrams showing trunk and distribution segments, cable type, transmission path length, CFP numbers, etc. to verify the requirements are met.

Provide a print out of all design calculations. Data must include calculated signal levels at each user (outbound) port at 150 and 450 megahertz, and calculated signal levels at each distribution (inbound) port at 5 and 112 megahertz. Minimum gain at each distribution port must be 6.0 dB.

Perform calculations on a computer using approved system design software. Submit data on the type of program used to perform the calculations.

Submit a bill of material listing all parts and components for the installed system by manufacturer's name, quantity, part number, and nomenclature, and recommended spares level required for normal maintenance and unscheduled repairs.

1.5.4 QUALIFICATIONS

Submit the qualifications of the manufacturer, contractor, and the installer to perform the work specified herein. Include proof of the minimum qualifications specified herein.

1.5.5 TEST PLAN

A test plan defining the tests required to ensure that the system meets technical, operational, and performance specifications, must be submitted 30 days prior to the proposed test date. The test plan must be approved before the start of any testing.

Provide all required test equipment. Equipment calibration must be traceable to national standards.

The test plan must identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

### 1.5.6 FIELD TEST REPORT

Submit test reports in booklet form with witness signatures verifying execution of tests. Reports must show the field tests performed to verify compliance with the specified performance criteria. Test reports must include record of the physical parameters verified during testing. Submit test reports within fourteen (14) days after completion of testing.

### 1.5.7 OPERATION AND MAINTENANCE MANUALS

Provide commercial off the shelf manuals for operation, installation, configuration, and maintenance for all products provided as a part of the BCDS system. Provide the operations and maintenance documentation in electronic form, MS Word or Adobe Acrobat format on CD media.

### 1.5.8 AS-BUILT DRAWINGS

At the completion of the project, submit final record "As-Built" drawings of the following:

Scaled 1:50 1/4 inch per foot main equipment room floor plans showing all installed BCDS components.

Scaled 1:100 1/8 inch per foot building floor plans showing routing of trunk cables, distribution cables, locations of taps, and all BCDS outlets. Number all outlets and taps as indicated on the cable schedule.

Drawings must be CAD generated on size "F" sheets. Submit reproducible hard copies and electronic copies in ".DXF" or ".DWG" format.

### 1.5.9 CABLE SCHEDULE

At the completion of the project, submit cable schedules indicating label at each end, and installed length. Format must comply with KSC-STD-E-0012. Schedule must be in 216mm by 279mm 8-1/2 inches by 11 inches format. Submit hard copy, and copy of electronic file in "Excel" (.xls) format.

## 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage must be stored with protection from the weather, humidity and temperature variation, dirt and dust or other contaminants.

## 1.7 SYSTEM COORDINATION

Coordinate with the Contracting Officer and respective support contractor for exact system installation requirements, and requirements for interface with the center-wide BCDS network.

# PART 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

Materials and equipment must conform to the respective TIA/EIA-606-A,

IEEE Std 802.7, NFPA 70, 47 CFR 76.605, and the requirements specified below.

The BCDS installation must incorporate system equipment compatible with the planned distribution of high definition television (HDTV) compressed digital signals.

## 2.2 CABLE

### 2.2.1 Trunk and Distribution Cable

Trunk and distribution cable must be broadband 0.5 inch CATV cable, semi-flexible coax, or where the bend radius is less than 4 inches, Type RG-11. Cable jacket must be factory marked at regular intervals, indicating verifying organization and performance level. Cable must be rated plenum (CMP) per NFPA 70 when installed in ducts, plenums and other air-handling spaces. For cable subject to moisture from flooding or to atmospheric contamination, use cable protected by a black polyethylene jacket with a flooding or other water migration deterrent compound between the jacket and the aluminum shield. Underground, flooded cable must have sequential footage marking on the outer jacket.

The 0.5 inch CATV semi-flexible coaxial cable must be Times Fiber T10500J/ T10500JB or approve equal with the following characteristics:

a. Copper-clad aluminum center conductor.

b. Foamed polyethylene dielectric produced by gas injection in combination with enhanced dimensional uniformity.

c. Seamless high purity electrical grade aluminum tube outer conductor (ASTM B 221).

d. 75 ohms impedance.

e. Nominal capacitance of 15.6 pF/ft (51.2 pF/m)

f. 87 percent nominal velocity of propagation.

g. Abrasion resistant, low coefficient of friction medium density black polyethylene jacket(Federal Specification LP-390 and ASTM D 1248 jacketing material).

h. Maximum attenuation characteristics:

| Frequency(MHz)@68°F(20°C) | dB/100 ft | dB/100 meters |
|---|---|---|
| 5 | 0.16 | 0.52 |
| 55 | 0.55 | 1.80 |
| 211 | 1.08 | 3.55 |
| 250 | 1.19 | 3.92 |
| 270 | 1.24 | 4.07 |
| 300 | 1.31 | 4.30 |
| 330 | 1.38 | 4.54 |
| 350 | 1.43 | 4.69 |
| 400 | 1.53 | 5.02 |
| 450 | 1.63 | 5.35 |
| 500 | 1.73 | 5.68 |
| 550 | 1.82 | 5.97 |

| Frequency(MHz)@68°F(20°C) | dB/100 ft | dB/100 meters |
|---|---|---|
| 600 | 1.91 | 6.27 |
| 750 | 2.16 | 7.09 |
| 870 | 2.35 | 7.69 |
| 1000 | 2.53 | 8.30 |

The RG-11 coaxial cable must be CommScope F11SSV or equivalent with the following characteristics:

a. No. 14 AWG copper-clad steel center conductor.

b. Gas expanded polyethylene dielectric with nominal 7.11 mm 0.28 inches outer diameter.

c. Aluminum-polypropylene-aluminum laminated tape shield with overlap bonded to the dielectric.

d 34 AWG aluminum braid wire shield with 60 percent coverage.

e. Non-bonded tape shield.

f. 34 AWG aluminum braid wire shield with 40 percent coverage.

g. 75 ohms impedance.

h. 82 to 85 percent nominal velocity of propagation.

i. PVC jacket with nominal diameter of 0.405 inches

j. Maximum attenuation characteristics:

| Frequency(MHz)@68°F(20°C) | dB/100 ft | dB/100 meters |
|---|---|---|
| 5 | 0.38 | 1.25 |
| 55 | 0.96 | 3.15 |
| 83 | 1.18 | 3.87 |
| 187 | 1.75 | 5.74 |
| 211 | 1.90 | 6.23 |
| 250 | 2.05 | 6.72 |
| 300 | 2.25 | 7.38 |
| 350 | 2.42 | 7.94 |
| 400 | 2.60 | 8.53 |
| 450 | 2.75 | 9.02 |
| 500 | 2.90 | 9.51 |
| 550 | 3.04 | 9.97 |
| 600 | 3.18 | 10.43 |
| 750 | 3.65 | 11.97 |
| 865 | 3.98 | 13.05 |

2.2.2 Outlet Drop Cable

Outlet drop cable must be broadband CATV cable, Type RG-6. Cable jacket must be factory marked at regular intervals, indicating verifying organization and performance level.

RG-6 coaxial cable must be Belden 82120 or equivalent with the following characteristics:

a. No. 18 AWG copper-clad steel center conductor.

b. Aluminum foil-polyester tape inner shield with 100 percent coverage and aluminum foil/braid outer shield with 95 percent coverage.

c. Characteristic impedance of 75 ohms.

d. Foam FEP dielectric.

e. Nominal capacitance, conductor to shield, of 16.5 pf per 100 ft.

f. Maximum operating voltage of 300 V RMS.

g. Maximum attenuation characteristics:

| Frequency(MHz)@68°F(20°C) | dB/100 ft | dB/100 meters |
|---|---|---|
| 10 | 0.90 | 3.0 |
| 50 | 1.90 | 6.20 |
| 100 | 2.60 | 8.50 |
| 200 | 3.70 | 12.1 |
| 400 | 5.00 | 16.6 |
| 700 | 6.60 | 21.7 |
| 900 | 7.40 | 24.3 |
| 1000 | 8.10 | 26.6 |

## 2.3 CONNECTING HARDWARE

### 2.3.1 Drop Cable Connectors

Connectors must be Type 'F' terminators. User outlets must be as configured on the drawings and provided with a self-terminating Type 'F' barrel, and be provided with locking terminator. Incorporate connectors into the customer faceplate (CFP) with telecommunication system services at locations indicated on the drawings.

#### 2.3.1.1 Trunk and Distribution Cable Connectors

Connectors must be the "KS" Type 5/8-24 threaded pin type. The connectors must be designed for the cable dimension, tolerance and assembly to ensure proper connection and termination.

### 2.3.2 Taps

Taps must be 8-port with RFI shielding and tap values selected to meet distribution design goals. The last tap in the distribution string must have its thru port terminated in 75 ohms. Accomplish this using a Type 'KS' male to Type 'F' female adaptor, and a Type 'F' terminator.

### 2.3.3 Patch Cables

Patch cables must be RG-6 cable assemblies consisting of flexible coaxial cable with Type 'F' connectors at each end. Provide 3 meter a patch cable for each user outlet. Field fabricated BCDS patch cables are acceptable.

### 2.3.4 Splitters

Splitters must be contained in a die cast aluminum housing with mountable

tabs and grounding blocks. They must be provided with RFI shielding and rated for performance to 1000 MHz. The two-way splitter nominal insertion loss at 450 MHz must be 3.9 dB, with a maximum insertion loss at 450 MHz of 4.3 dB. Isolation from 10 to 860 MHz must be 20 dB minimum, with a return loss at 30 to 750 MHz of 18 dB maximum. The splitters must also be available in a three-way configuration.

### 2.3.5 Directional Couplers

Directional couplers must be contained in a die cast aluminum alloy housing with mountable tabs, rated for performance up to 1000 MHz, and be available in a range of tap values of 16, 12, 9, and 7 dB. Maximum input return loss must be 18 dB over 30 to 750 MHz and 16 dB over 750 to 1000 MHz. Isolation from 10 to 860 MHz must be 20 dB minimum for all tap values exclusive of 16 dB, which must have a minimum isolation of 22 dB.

### 2.3.6 In-Line Equalizers

In-line equalizers must provide compensation of RF signal level and tilt for inbound and outbound transmission paths. In-line equalizers must be consistent with the split of the RF spectrum.

## 2.4 EQUIPMENT

Active equipment, including amplifiers and power supplies, must be sized and provided as necessary to meet the requirements of the system design. All system equipment must be compatible with the planned distribution of standard definition (SDTV) and high definition television (HDTV) compressed digital signals.

### 2.4.1 Power Supply

Power supply must be rated for 120 VAC, 60 HZ input, with plus or minus 2 percent (worst case line/load regulation), and 60-90 VAC output at the required ampere capacity. The required ampere capacity must be determined during the design phase, based on the number of required amplifiers.

Efficiency must be a minimum of 80 percent at full load with isolation at RFI filter of 40 dB, 5 to 860 MHz. Provide the unit with an internal test point and meters for voltage and current, front panel circuit breaker and pilot light. Provide a method of power backup, using an uninterruptible power supply or resident battery system.

### 2.4.2 Amplifier

Amplifier must be capable of being wall mounted on a wall with suitable mounting hardware. The forward path passband must be 80 to 862 MHz minimum. The return path passband must be 5 to 65 MHz minimum. Provide amplifier complete with a status monitor transponder. The amplifier housing must accept the return path transmitter and the forward path receiver. Amplifier performance criteria must meet or exceed the design requirements.The system must employ no more than three cascaded trunk amplifiers.

### 2.4.3 Return Path Transmitter

Transmitter wavelength must be 1310 nm. Mounting the transmitter in the amplifier housing is acceptable. Fiber optic connectors must be FC/APC style.

2.4.4 Forward Path Receiver

Receiver must be capable of receiving 1550 nm wavelength. Mounting the receiver in the amplifier housing is acceptable. Fiber optic connectors must be FC/APC style.

2.5 EQUIPMENT MOUNTING BACKBOARD

Provide plywood backboards, sized as shown, painted with fire retardant paint.

2.6 CABLE SUPPORTS

Cable supports must be flexible cable wrap type, large bundle supports manufactured for the purpose of supporting low-voltage cable. Units must be adjustable to a 102mm - 152mm 4 inches or 6 inches diameter loop, be mounted to the building structure in an approved manner. Unit must be suitable for use in a plenum space.

2.7 LABELS

Specify labels in Section 27 15 00.00 98 COMMUNICATIONS HORIZONTAL CABLING.

2.8 EQUIPMENT CABINET

Cabinet must be as manufactured by "Optima" to match existing equipment at the center.

BCDS equipment cabinet must meet the following criteria:

a. Floor mounted, beige colored 16 gauge steel construction.

b. Heavy-duty aluminum frame.

c. Die-cast aluminum corner sockets.

d. Extruded aluminum bezels.

e. Interior welded joints.

f. Standard mounting rails.

g. Nominal 77 inches H by 19 inches W by 30 inches D.

h. Lockable smoked plexiglass hinged door on front and steel hinged, louvered door in rear. Doors must be field reversible.

i. Vented roof.

j. Removable side panels.

k. Leveling feet.

PART 3 EXECUTION

3.1 INSTALLATION

Install system components and appurtenances in accordance with NFPA 70,

manufacturer's instructions and as shown. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with TIA/EIA-606-A. Firestop penetration in fire-rated construction in accordance with Section 27 11 19.00 98 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS. Install conduits, outlets and raceways in accordance with applicable sections of this specification. Install wiring as specified in these specifications. Mark wiring, and terminal blocks and outlets in accordance with TIA/EIA-606-A. Cables must not be installed in the same cable tray, utility pole compartment, or floor trench compartment with AC power cables. Cables not installed in conduit or wireways must be properly secured and neat in appearance, and if installed in plenums or other spaces used for environmental air, must comply with NFPA 70 requirements for this type of installation.

3.1.1 Cable

Route BCDS cable preferably to the exterior of the telephone and data cabling, from the communications room, out to the work station, using appropriate mounting hardware. Coordinate requirements with Section 27 15 00.00 98 COMMUNICATIONS HORIZONTAL CABLING. Where only BCDS is required at a CFP, the rough-in and finish CFP must be the same as specified in Section 27 15 00.00 98 COMMUNICATIONS HORIZONTAL CABLING

The rated cable pulling tension must not be exceeded. Cable must not be stressed such that twisting, stretching or kinking occurs. Cable must not be spliced. Provide adequate slack at each end for future termination. Above the ceiling at each outlet, coil 914mm 36 inches of slack cable that allows future removal of the existing termination, and re-termination using a new device.

Suspend coaxial cable not in a wireway a minimum of 150 mm 6 inches and a maximum of 300mm 12 inches above ceilings by cable supports. Cable supports must be a minimum of 915 mm 3 feet and a maximum of 2440 mm 8 feet apart. Cable must not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

Avoid placement of cable parallel to power conductors, if possible; maintain a minimum separation of 50mm 2 inches per NFPA 70 Article 820-52 when such placement cannot be avoided. Terminate all cables; no cable must contain unterminated elements. Minimum bending radius must not be exceeded during installation or once installed. Cable ties must not be excessively tightened.

In raised floor areas, install cable after the flooring system has been installed. Cable 1.8 mm 72 inches long must be neatly coiled below each feed point in raised floor areas.

No cable must sag more than 203 mm 8 inches and must not touch any lighting fixture or drop ceiling in any way.

No cable must be spliced or otherwise re-terminated to fulfill the requirements of the job, other than at the wall outlet and communications closet.

All cable must be run above as many obstructions as possible such as ducts, other cabling, conduit, piping, etc.

No cable must be tie wrapped closely parallel or directly on electrical

conduit.

Label all cables at each end as indicated in the cable schedule.

All BCDS cable with the exception of trunk and distribution cable, must be routed from the nearest 8-port multi-tap to the user outlet, and routed through ceilings in neatly tie wrapped bundles, and secured to structural members, unless otherwise stated on the design in conduit. Where cables must pass through drilled openings, install conduit sleeve proportionally to the feed-thru distance at all locations. Install appropriate fire caulk per NFPA 70.

One pull string must be provided in each bundle, and up from each station outlet, and secured up in the ceiling space.

Conduct a walk through with the Contracting Officer prior to installation to examine installation conditions. Replacement of any tiles or other materials damaged during installation is the responsibility of the installing contractor.

Install trunk and distribution cable in a manner that there is no visible damage to the cable outer conductor, due to improper bonding or handling during installation.

3.1.2 Taps

Install taps at 60mm 30 inches on center or at intervals as dictated by the design, on distribution lines. Extend drop lines directly from the tap to the outlet, with no splices or taps. Securely fasten the tap to the building structure, and ground in accordance with manufacturer's recommendations. Label all taps as numbered in the Cable Schedule.

3.1.3 Outlets

Install connectors in CFP's at all locations shown on the drawings that are to contain a BCDS service. Coordinate with requirements for other systems required in the CFP. Label all BCDS outlets in CFP's as numbered in the Cable Schedule.

3.1.4 Equipment

Locate all active equipment in the facility communications room(s).

Where required, wall mount amplifiers on the BCDS equipment backboard in the communications equipment room/closet. Power supplies must be [floor], [wall], or [rack] mounted,as required by the conditions.

Provide all line voltage circuits, appropriate AC receptacles and grounding as required by the manufacturer's recommendations and NFPA 70. Label all equipment with designated name and number.

3.2 TERMINATION

Cables and conductors must sweep into termination areas; cables and conductors must not bend at right angles. Manufacturer's minimum bending radius must not be exceeded. When there are multiple system type drops to individual work stations, maintain relative position for each system on each system termination block or patch panel.

### 3.2.1 Coaxial Cable

Terminate all cables at each end. Terminate trunk and distribution cables with appropriate connectors or end-of-line terminators as required. Terminate loop-type cable systems with appropriate drop connectors and terminators as required. Trunk cable shield conductor must be grounded to communications ground at only one point and must not make electrical contact with ground anywhere else.

## 3.3 GROUNDING

Install signal distribution system ground bus in the telecommunications entrance facility and in each telecommunications closet, in accordance with [_____]. Connect frames/housings to the ground bus.

## 3.4 ADDITIONAL MATERIALS

Provide the following additional materials required for facility startup.

a. An amount of "F" connectors equal to 5 percent of the total number installed.

b. An amount of 8-port taps equal to 5 percent of the total number installed, with a minimum of one.

c. An amount of patch cables equal to 5 percent of the total number installed.

d. One (1) set of any and all special tools required for cable preparation/termination such as coring tools, jacket removal, cable-cutters, center conductor foam removal and cable strippers. This is applicable for all types of installed cable to establish cross connects and to change and/or maintain equipment.

## 3.5 TESTING

Materials and documentation to be furnished under this specification are subject to inspections and tests. Terminate all components prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

Test 100 percent of the installation, including ALL terminations.

Test each outlet post-termination using an appropriate instrument to verify both the integrity of all conductors and correctness of the termination sequence.

Test equipment must include the following:

a. Calan model 3010R or equal Sweep Generator.

b. Calan model 3010R with Option 52 or equal Sweep Generator.

c. Wavetek Model C1 or Equal Oscilloscope Camera.

d. Miscellaneous test cables, connectors, and adapters.

### 3.5.1 Trunk Cable Test

Trunk Cable Test:

Connect a sweep generator to either end of the cable through appropriate adapters and test cable (the test cable must be as short as possible). Connect the sweep recovery unit to the other end of the trunk cable through the appropriate adapters and test cable (minimum length). Set the sweep generator to sweep from 5 megahertz to 862 MHz with an output level of plus 50 dBmV. The sweep display must have a smooth slope free of ripples (no more than 1 dB peak to valley change within a 6 megahertz bandwidth) or other distortions with the highest level at 5 megahertz and the lowest level at 400 megahertz. The lowest level must exceed plus 30 dBmV for proper system operation. The actual level is dependent on the length of the trunk cable.

If the cable run contains directional couplers and/or splitters, include these devices in the sweep tests. All unused cable lengths connected to the directional couplers and/or splitters must be terminated with a 75-ohm terminator when each segment is swept.

Set the sweep recovery unit markers to display the maximum and minimum levels on the sweep. Photograph the sweep presentation using the oscilloscope camera. Label the photograph with scale, date, and cable nomenclature.

### 3.5.2 Branch Cable Test - Forward

Branch Cable Test - Forward: Connect a sweep generator to the amplifier end of the branch cable through the appropriate adapters and test cable (the test cable must be as short as possible). Connect the sweep recovery unit to the tap end of the cable at the output of the last tap (remove the 75-ohm end of the branch terminator and install the test cable) using a minimum length test cable. Set the sweep generator to sweep from 80 megahertz to 862 megahertz with an output level of plus 50 dBmV. The sweep display must have a smooth slope free of ripples (no more than 1 dB peak to valley change within a 6 megahertz bandwidth) or other distortions with the highest level at 80 megahertz and the lowest level at 862 megahertz. The lowest level must exceed plus 22 dBmV for proper system operation. The actual level is dependent on the branch length and the number of taps.

Set the sweep recovery unit markers to display the maximum and minimum levels of the sweep. Photograph the sweep presentation using the oscilloscope camera. Label the photograph with scale, date, and cable nomenclature.

### 3.5.3 Branch Cable Test - Reverse

Branch Cable Test - Reverse. Connect a sweep generator to the tap end of the cable through appropriate adapters and test cable (the test cable must be as short as possible). Connect the sweep recovery unit to the amplifier end of the branch cable through the same test cable used for the forward sweep. Set the sweep generator to sweep from 5 megahertz to 65 megahertz with an output level of plus 50 dBmV. The sweep display must have a smooth slope free of ripples (no more than 1 dB peak-to-valley change within a 6 megahertz bandwidth) or other distortions with the highest level at 5 megahertz and the lowest level at 65 megahertz. The lowest level must exceed plus 29.5 dBmV for proper system operation. The actual level is dependent on the branch length and the number of taps.

Set the sweep recovery unit markers to display the maximum and minimum levels of the sweep. Photograph the sweep presentation using the oscilloscope camera. Label the photograph with scale, date, and cable nomenclature.

NOTE: Equalizer modules, both high frequency and low frequency, must be installed in the equalizer housings prior to testing. Note that equalizers are only in the branch distribution cable system.

3.5.4 Coaxial Cable

Test cable for continuity, shorts and opens. Verify characteristic impedance over the range of intended operation. Verify cable length. Sweep test cable for attenuation over the range of intended operation.

The installed system must have an outbound path loss of 39 plus or minus 3 dB, as measured from the distribution port of the amplifier, to any user outlet port, based on a distribution level of 45 dBmv.

The inbound path loss must be 32.5 plus or minus 3 dB, as measured from any user outlet port, back to the distribution port of the amplifier. The 32.5 dB level is based on a 50 dBmv transmitter level from a cable modem or converter box. This level must provide a 17.5 dBmv input level at the distribution port.

Verify continuity of all installed user cables after termination of Type "F" connectors.

Repair/replace any defective components at no cost to the Government.

-- End of Section --